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THE GEOLOGICAL SURVEYS OF ARKANSAS.

The Owen Survey.—The subject of a state geological survey of Arkansas was first brought to public attention by Governor Elias N. Conway in his message to the legislature in 1856. Upon his recommendation the matter was taken into consideration and the first geological survey of the state was begun under an act passed January 4, 1857. This act provided for the appointment of a state geologist by the Governor, and an appropriation of \$4,800 per annum, out of which all expenses were to be paid. Dr. David Dale Owen, then state geologist of Kentucky, was appointed state geologist of Arkansas, and entered upon his duties October 1, 1857. The results of the work done in 1857 and 1858 are given in Owen's "First report of a geological reconnaissance of the northern counties of Arkansas," Little Rock, 1858.

In his message to the legislature of 1858-9 Governor Conway recommended more generous support of the survey. There were those in the legislature, however, to whom the collecting of fossils and the examination and location of rocks seemed a ridiculous occupation for state officers to say nothing of its being a waste of the state funds, and every effort was made by them to defeat the appropriation bill.¹

¹ Some idea may be had of the ridicule heaped upon it from the following extracts from amendments offered to the survey bill.

"Mr * * * offered to amend by adding the following after section 11, viz :

"SEC, 12. The same amount which is appropriated to the State Geologist, shall likewise be appropriated to a phrenologist, * * * and a like amount to an ornithologist, and their several assistants who shall likewise be appointed by the Governor, and shall continue in office fifty-four years * * *; and the Secretary of State shall forward one copy of each report to the Governor of each state in the Union, except such as may be known to be black republican governors; also, one copy to the Queen of England, and to the Emperors of France and Russia; also, a copy to the Queen of Spain: provided that government will sell Cuba to the United States on reasonable terms."

"SEC. 14. It shall be the duty of the phrenologist to examine and report upon the heads of all the free white male and female citizens in the state, and their children, except such as may refuse to have their heads examined."

The bill providing for the continuation of the survey passed in February, 1859; by its provisions the state geologist's salary was raised from \$1,800 to \$2,500, and an appropriation of \$6,000 per annum was made for the survey work. Under this act Dr. Owen was again appointed state geologist. Before the next legislature convened Dr. Owen died (November 13, 1860) and his "Second report of a geological reconnoissance" was edited by his brother, Dr. Richard Owen, and Prof. J. P. Lesley and was printed at Philadelphia in 1860.

Dr. Owen's efforts were devoted entirely to the work of reconnoissance, the first report treating the region north of the Arkansas River, and the second that south of the river. In the main his ideas of the geological structure of the state were correct, and his facts have been of great service in working out the details of the structure and the areal geology. Errors were made, but they were few and unimportant, especially when we take into consideration the limited time and small means at the disposal of the survey. It may be well to mention the more fundamental of these errors, because they have so long been current :

I. It was thought that the Arkansas coals belonged to the Lower Coal Measures. Coal does occur in the Lower Coal Measures north of the Boston Mountains, and the generalization was made from these beds. The coal of the Arkansas valley is in an altogether different position—near the top of the Coal Measures.

II. It was thought that the novaculites, now known to be Silurian, were Carboniferous. No fossils had then been found in or near the novaculites.

III. The theory of northeast-southwest metalliferous veins across the state, although advanced only as "probable," led to much searching for silver and lead, much loss of time and money, and to much disappointment.

The civil war broke out shortly after the publication of Owen's second report, and all such work was necessarily suspended in the southern states. No steps were taken to finish

the geological survey of Arkansas until after the close of the war.

The Reconstruction Surveys.—In the General Assembly of 1866 a bill was passed by the Senate providing for a geological survey of the state, but it was rejected by the Lower House.¹

In his message to the General Assembly of 1868 General Powell Clayton, then Governor of the state, recommended the continuation of the survey begun by Owen, but the committee to which the matter was referred reported that "owing to the unsettled state of the country and the lack of funds to prosecute the above work" the bill should be indefinitely postponed.

In the legislature of 1871 a survey bill was passed (and approved March 28, 1871) appropriating \$15,000 for two years work. Under this act Governor O. A. Hadley appointed W. F. Roberts, Sr., of Pennsylvania, state geologist. The records in the office of the Secretary of State do not show how long Mr. Roberts held office, but he was appointed June 5, 1871, and in his message to the General Assembly in 1873 Governor Hadley says that he returned to Pennsylvania "last July, and I have not heard from him since."

Dr. George Haddock, then of Arkadelphia, was, upon Governor Hadley's recommendation, appointed Mr. Roberts' assistant, and went with him through the western part of the state.

Mr. Roberts' report was never delivered to the Governor, but, according to his own statement,² it was deposited in a bank, because the state was unable to print it. A series of articles, however, was subsequently published by Mr. Roberts in the *Age of Steel* of St. Louis, Missouri (1887-88), and it is probable that these articles represent his views of the geology of the state, and give the results of his work. They are largely a repetition of the results given by Owen.

¹ This bill appropriated \$13,000 for the survey for two years—1867 and 1868. The vote in the House was 30 to 27 against the bill; in the Senate it was 17 to 6 in its favor.

² Made to the writer in 1888.

In 1873 Dr. George Haddock, who had been Mr. Roberts assistant, published at Little Rock a pamphlet of 66 pages entitled "Report of a Geological Reconnoissance of a part of the State of Arkansas made during the years 1871-72." This paper gives the only results of the work done under this appropriation.¹ It is of but little or no importance and adds nothing to the work done by Owen.

The General Assembly of 1873 passed a bill for the continuation of the survey, and made an appropriation of \$15,000 for it.²

Under this act the following state geologists were appointed: *George Haddock*, appointed May 15, 1873, removed from office January 14, 1874. Mr. Haddock, who is said to have been a Scotchman, had been assistant geologist under Mr. Roberts the year before; he made no report except the one published under a former appropriation and mentioned above. *William C. Hazeldine*, appointed January 14, 1874, and removed June 29, 1874. Mr. Hazeldine was an Englishman by birth; he had been sent to the State Legislature from Richmond, Little River county, in 1871. Later he was circuit Judge of the Second District of Arkansas, and lived at Augusta, Woodruff county. As state geologist he made no report, and, so far as can be ascertained, did no field-work. *Arnold Syberg* was appointed June 29, 1874, and remained in office to the end of the term. Mr. Syberg is a native of Prussia; he was at one time a captain in the regular army of the United States, afterwards state engineer of the State of Arkansas, and still later engineer in the Confederate army. He still lives at Little Rock. Mr. Syberg says that he made no report, and that the only work he did was to receive and examine specimens sent or brought in from various parts of the state.

The total amount appropriated for the 1873-74 survey—

¹ The books in the Auditor's office show that \$10,700 of this appropriation was drawn out, and that the remaining \$4300 was carried over to the next survey account.

² For minority report against the appropriation see *Senate Journal*, 1873, p. 450, *et seq.*

\$15,000—was spent, and, in addition thereto, the Legislature voted \$2386¹ in a deficiency bill.

The failure of the surveys for years 1868 to 1875 to yield any geological results must be attributed to the general demoralization of the state government during the reconstruction period.

No further efforts were made to carry on a geological survey until the year 1881, when bills for such work was defeated in both branches of the General Assembly.

In the Assembly of 1883 the only legislation passed relating to geological work was a Senate concurrent resolution "authorizing and directing the Governor to make application to the Secretary of the Interior of the United States for a geological survey of the State of Arkansas." Nothing seems to have come of this effort to obtain help from the national government.

The Branner Survey.—The last survey of the state was publicly suggested by Governor Simon P. Hughes in his message to the General Assembly in January, 1887, and on January 19th of that year Hon. Elias W. Rector, Representative from Garland county, introduced in the Lower House an act providing for a geological survey of the State of Arkansas.²

This bill provided for a state geologist and three assistants. The geologists were to be paid from the appropriation for the state officers, and printing, stationery, postage, fuel, and lights were to be paid for out of funds to furnish supplies and to do printing for state officers, while \$10,000 was appropriated in the survey bill proper to pay contingent expenses. The bill required that the survey should be completed in two years. Under this act J. C. Branner, at the time professor of geology in the University of Indiana, was appointed state geologist; he entered upon the duties of his office June 24, 1887.

At the next meeting of the General Assembly, in 1889, there was much and violent opposition to the continuance of the

¹ The biennial report of the State Treasurer for 1874 shows that he paid \$19,628 to the state geologist.

² It was referred to the Committee on Judiciary, reported back favorably, fully discussed and passed February 24, 1887, by a vote of 53 to 19; the same bill passed the Senate by a vote of 28 to 1, and was approved by Governor Hughes, March 5, 1887.

survey, due chiefly to the fact that the survey had declared fraudulent certain so-called gold mines in the western part of the state; but, under the leadership of Mr. Rector, a bill for its continuation was passed. This new bill was in the form of an amendment of the bill of 1887, and was so worded as to make it unnecessary for subsequent assemblies to do more than vote the money required for the general appropriations. This amendment fixed the contingent fund at \$10,000 for two years, and gave the state geologist four assistants in place of the two previously provided for. Under this bill J. C. Branner was re-appointed state geologist. The General Assembly of 1891 made the same appropriations as the previous one, and the same state geologist was again appointed. When this last appropriation was made, it was stipulated that it should finish the survey's work, and that the survey should be brought to a close by the end of March, 1893. When the Assembly met, therefore, in 1893 the field-work had been finished, or as nearly so as possible, and the only appropriations asked for was one to be used to complete the preparations of the reports. For this purpose an appropriation of \$4000 was made to be expended under the direction of the Governor. It was understood also that the former state geologist should prepare the reports without expense to the state beyond the assistance he might need in office and clerical work, and that the printing, engraving, and binding of the reports should be paid for as before out of the general appropriations to pay for that work for the state. The reports of the survey are now all published except the four volumes mentioned below.

Some wonder is occasionally expressed that a state geologist should undertake to bring the work of a survey to a definite close, instead of insisting upon the fact that a state geological survey is an essential, and should be a permanent, part of every state government. Whether every state should maintain a permanent geological survey depends upon circumstances and conditions that cannot be discussed in this place. So far as the case in hand is concerned, it seemed, and still seems, better that with

fair appropriations and salaries the work should be pushed energetically and brought to a definite end, rather than that appropriations should dwindle to a point forbidding creditable work. Believing that the people are entitled to what they pay for, it has been the aim of the present survey to meet the reasonable expectations of the people of the state in giving them practical and economic results, and at the same time to do all the purely scientific work that the means at the survey's disposal would admit of, or that the study of economic problems demanded.

The reports are mainly in the form of monographs of the subjects treated: thus all the facts gathered relating to the manganese are brought together in the manganese report; those relating to the novaculites are given in the report on novaculites, and every thing known of the igneous rocks of the state is given in the report on igneous rocks, etc. Besides the evident advantage of having the subjects thus grouped in monographs, this method has kept down the number of volumes, has prevented the publication of undigested field notes, and has greatly reduced the cost of printing. The disadvantages of such a system are that the bulk of the work upon a given subject must be done by one person, and, in the case of formations that extend over wide areas and require much detailed study, it is impossible to bring out the results promptly. The clay report, for example, has been in hand since 1887, and is not yet published. The delay in publication is also liable to work injustice to assistants by their results being anticipated. This can be prevented to a certain extent by publishing results of special interest in scientific periodicals.

In the case of the Arkansas survey this method of publication has not been carried out without legal difficulties. The law establishing the survey says: "Section 4. It shall be the duty of said geologist, on or before the first Monday in December of each year . . . to make a printed report to the Governor of the results and progress of the survey, accompanied by such maps, profiles, and drawings as may be necessary to exemplify the same,

which reports the Governor shall lay before the General Assembly."¹

Annual reports are the only ones provided for, and it is for this reason that the volumes, instead of being numbered consecutively, are given as annual reports, and divided into volumes, one volume generally being devoted to a single subject.

The greater part of the topographic maps made by the survey will accompany the final report on coal. They embrace an area of 3240 square miles; the maps are on a scale of one mile to the inch, the contour interval is twenty feet. The total area mapped topographically is 4,500 square miles, while topographic sketch maps have been made of about double that area, and special areas have been mapped on scales varying from 300 to 1,000 feet to the inch.

The following are the reports published under the Branner survey.²

Annual Report for 1887.—Administrative (pamphlet). Pp. 15.

Annual Report for 1888.

Vol. I.—Gold and silver. Pp. 320 + xxxi; 2 maps.

Vol. II.—Mesozoic. Pp. 319 + xiv; illustrated; 1 map.

Vol. III.—Coal (preliminary). Pp. 120 + x; illustrated; 1 map.

Vol. IV.—Washington county; Plant list. Pp. 262 + xiv; illustrated; 1 map.

Annual Report for 1889.

Vol. II.—Crowley's Ridge. Pp. 283 + xix; illustrated; 2 maps.

Annual Report for 1890.

Vol. I.—Manganese. Pp. 642 + xxvii; illustrated; 3 maps.

Vol. II.—Igneous rocks. Pp. 457 + xv; illustrated 6 maps.

Vol. III.—Novaculites. Pp. 443 + xx; illustrated; 2 maps.

Vol. IV.—Marble. Pp. 443 + xxiv; illustrated; atlas of 6 maps.

Annual Report for 1891.

Vol. I.—Mineral waters. Pp. 144 + viii; 1 map.

Vol. II.—Miscellaneous—Benton county; Elevations; River observations; Magnetic observations; Mollusca; Myriapoda; Fishes; Dallas county. Pp. 349 + xii; illustrated; 2 maps.

Annual Report for 1892.

Vol. I.—Iron deposits. Pp. 153 + x; 1 map.

Vol. II. Tertiary. Pp. 207 + xiv; illustrated; 1 map.

¹ Acts of Arkansas, 1887, p. 58.

² A bibliography of the Geology of Arkansas is given in Vol. 11 An. Rep. Geol. Survey of Arkansas, 1891, pp. 319-340.

There are also in press or in manuscript four volumes, as follows : The final report on coal ; the report on the Lower Coal Measures ; the report on clays, kaolins and bauxites ; the report on zinc.¹ A bulletin upon the palæontology of the state is being prepared by Dr. H. S. Williams, of Yale University ; it will be published by the United States Geological Survey.

The following are some of the general economic results of the Survey's work :

1. The areal and structural geology of the state in so far as the subdivisions are known. (The exact parting between the Carboniferous and Lower Carboniferous along the southern margin of the Carboniferous is not known ; indeed it is not known whether the Lower Carboniferous comes to the surface south of the Arkansas River.)

2. Reporting upon the reputed gold mines of the state.

3. Outlining the coal area.

4. Determining and pointing out the adaptabilities of the various coals, and the best methods of mining and marketing them.

5. Showing the extent, value and method of locating manganese deposits.

6. Mapping and calling attention to the character, extent and distribution of the marbles and other limestones.

7. Discovery of chalk, giving its distribution, and suggesting uses to which it may be put.

8. Chemical analyses of the mineral waters.

9. Showing the character of the iron ores.

10. Discovery of bauxite and giving its distribution.

11. Pointing out the character, distribution, and availability of the clays of the state.

12. Determining by tests the character of the granites and giving their distribution.

¹ The survey reports are distributed by the writer to his correspondents at his personal expense and on his own account. Copies can generally be had, however, by geologists and capitalists by addressing the Honorable Secretary of State, Little Rock, Arkansas. It is necessary to state, on making application, that one is a capitalist or a geologist, and interested in the geology of Arkansas, and to prepay all postage or to order the reports sent by express at his own expense.

13. Analyses and distribution of the zinc ores.

Some of the more comprehensive geologic problems that yet remain to be solved, relate to :

1. The palæontology of the state.
2. The physical geography.
3. Quaternary history.
4. Relation of the palæozoic beds to those of the other parts of the continent and to those of the world.
5. The divisions of the Silurian beds.

RESUMÉ OF APPROPRIATIONS AND PUBLICATIONS.

TERM.	GEOLOGIST.	APPROPRIATION.	REPORTS PUB.	VOLS.	PAGES.	MAPS
1857-8	D. D. Owen	\$ 4,800	First survey	1	256	0
1858-60	D. D. Owen	12,000	Second survey	1	431	1
1871-3	W. F. Roberts, Sr.	15,000	Haddock's }	1	63	0
1873-4	Geo. Haddock }	19,628	pamphlet }	0	0	0
	W. C. Hazeldine }		None			
	A. Syberg }					
Former surveys, seven years.		\$51,428		3	750	1

TOTALS OF BRANNER SURVEY.

1887-9	J. C. Branner	\$27,800	Reps. for '87-8	5	1105	5
1889-91	J. C. Branner	32,600	Reps. for '89-90	5	2373	21
1891-3	J. C. Branner	32,600	Reps. for '91-2	4	887	5
1893-5 ¹	J. C. Branner	4,000	In preparation	4	about 2000	38
Total,		\$97,000 ²		18	6365	69

Engraving, printing, and binding are not included in the total for the period 1887-95. Those items and the cost of fuel, lights,

¹ No field work was done after 1892; the appropriation was made in 1893 for completing the reports.

² A deficiency bill for \$2,340 was passed by the legislature in 1889. This sum, however, should not be added to the total amount appropriated because a somewhat larger amount reverted to the treasury that year from the appropriation for salaries. It is but just to add, moreover, that the work represented by the state geological reports was not all paid for by the state: about \$8000 worth of work was contributed by volunteer assistants; about \$5000 was spent on precise levels by the U. S. Coast and Geodetic Survey; about \$25,000 was spent in topographic work by the U. S. Geological Survey; about \$7000 worth of engraving was done by the U. S. Geological Survey, and a deficiency of about \$3000 was paid by the State Geologist.

stationery, and postage would probably bring the total expenditures of the Branner survey up to about \$120,000, and the total cost of all the state geological surveys up to \$171,428.

When all the conditions are considered, it must be recognized that great credit is due the people of the State of Arkansas for the liberality with which they have supported geological work.

JOHN C. BRANNER.

STANFORD UNIVERSITY, CALIFORNIA,
November 8, 1894.